GROUNDWATER MONITORING – ANNUAL EVENT
MARCH 2003
BOEING REALTY CORPORATION
FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

by

Haley & Aldrich, Inc.
San Diego, California

for

Boeing Realty Corporation
Long Beach, California

File No. 28882-101
May 27, 2003

HALEY & ALDRICH

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Prepared for

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May 27, 2003

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1. INTRODUCTION

Haley & Aldrich, Inc. (H&A) has prepared this report on behalf of Boeing Realty Corporation (BRC) in order to document the Groundwater Monitoring Annual Event (2003 Annual event) conducted at the Former C-6 Facility in Los Angeles, California (Site).

The 2003 Annual event was conducted at the Site from March 24th to the 28th, 2003. The program included the following activities:

- Groundwater elevation measurements in 20 wells;
- Groundwater samples from 20 wells and subsequent analysis for volatile organic compounds (VOCs) by US Environmental Protection Agency (EPA) Method 8260B; and
- Monitored natural attenuation (MNA) parameter measurements in 20 wells for dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, conductivity, and temperature.

This report provides documentation and discussion of the 2003 Annual event.

2. SITE BACKGROUND

2.1 Site Location

The Site is located at 19503 South Normandie Avenue, in Los Angeles, California. The Site occupies approximately 170 acres in an area located between the cities of Torrance to the west, and Carson to the east.

The Site is bound on the north by 190th Street; on the east by Normandie Avenue; on the west by the former Industrial Light Metals (ILM) facility; and on the south by the former Montrose Chemicals facility and a residential area. A Site location plan is included as Figure 1; a Site plan as Figure 2.

2.2 Site History

The Site was reportedly used for the manufacturing of aircraft and aircraft parts for 40 years, between 1952 and 1992. Prior to that time, industrial use of the Site included aluminum and steel production. Before 1940, the Site was reportedly farmland. A limited amount of assembly and warehouse related activities continued through mid-2000. The Site is currently demolished, and in various stages of redevelopment.

Groundwater investigation activities began at the Site in 1987. Forty groundwater monitoring wells have been installed at the Site. Twenty of these 40 wells have since been removed as a result of redevelopment activities. Prefixes of Site groundwater monitoring wells include BL, DAC, WCC, TMW and XMW. Table I is a compilation of the groundwater monitoring well details.

2.3 Regional Geology and Hydrogeology

A description of the geology and hydrogeology of the region surrounding the Site is drawn from reports published by the U.S. Geological Survey (USGS) (Poland and others, 1959) and the California Department of Water Resources (DWR, 1961). Reference is also made to previous Site reports prepared by Kennedy/Jenks Consultants (Kennedy/Jenks Consultants, 2000).

The Site is located on a broad plain, at an approximate elevation of 52 feet above mean sea level (MSL). The DWR and USGS define this area as the Torrance Plain, a Pleistocene-age marine surface and subdivision of the West Coast Basin/Coastal Plain of Los Angeles and Orange Counties. The ground surface is generally flat, with an eastward gradient of approximately 20 feet per mile (less than one-half percent). Surface drainage is generally toward the Dominguez Channel, approximately one mile to the east. The Dominguez Channel flows southeastward toward the Los Angeles and Long Beach Harbors, in San Pedro Bay.

The West Coast Basin includes a thick sequence (up to 13,000 feet) of marine and continental sediments (Miocene to Recent) deposited in a broad synclinal depression over a basement complex of igneous and metamorphic rocks. The uppermost sequence of deposits of interest within the West Coast Basin is as follows:

Youngest	Active Dune Sand
↑	Alluvium
	Older Dune Sand
↓	Lakewood Formation (upper Pleistocene)
Oldest	San Pedro Formation (lower Pleistocene)

The dune sands and alluvium are not present at the Site. The Lakewood Formation is mapped at the surface in the Site vicinity.

The Lakewood Formation (DWR, 1961) includes the upper Pleistocene deposits located in the sediments of the Los Angeles Coastal Plain area. These deposits are of marine and continental origin, and represent stream transport and sedimentation along the Pleistocene marine plain. In the Site area, the Lakewood Formation also may include the Semi-perched aquifer, the Bellflower Aquitard, and the Gage Aquifer. The Semi-perched aquifer includes deposits described as Terrace Cover (Poland and others, 1959). Based on correlations between Site stratagraphic and adjacent sites data, it appears that the Semi-perched aquifer is absent from the Site. The Bellflower Aquitard is a heterogeneous mixture of continental, marine, and wind-blown sediments, consisting mainly of clays with sandy and gravelly lenses (DWR, 1961). The elevation of the base of the Bellflower Aquitard is at about -100 feet MSL, or about 150 feet below ground surface (bgs) in the Site area. The Gage Aquifer is a water-bearing zone of fine to medium sand and gravel confined by the Bellflower Aquitard. It is reported to be approximately 40 feet thick in the Site area.

The Lakewood Formation is underlain by the Lower Pleistocene San Pedro Formation, which continues to approximately 1,000 feet bgs in the Site area. The major water-bearing zones within the San Pedro Formation are the Lynwood Aquifer and the Silverado Aquifer. These are reported in the Site area at approximately 300 and 500 feet bgs, respectively (DWR, 1961). The Silverado Aquifer is an important groundwater source in the Coastal Plain, and considered a source of drinking water (DWR, 1961).

2.4 Site Geology and Hydrogeology

2.4.1 Geology

Groundwater monitoring wells and soil borings drilled at the Site encountered the Lakewood Formation. Monitoring well borings were drilled from the ground surface to depths ranging from 79 to 140 feet bgs. The top 20 to 50 feet below the Site consisted of mainly fine-grained soils (predominantly silts and clays) that become thicker to the east. A sandy zone that dips downward to the east underlies the fine-grained soils. The sandy zone is generally 80 to 100 feet thick, and contains interbedded layers of fine-grained sediment that also dip down to the east.

2.4.2 Hydrogeology

Groundwater samples from monitoring wells at the Site have been collected and analyzed on a regular basis since 1987. The uppermost groundwater at the Site appears to be under water table conditions at elevations of approximately -12 to -16 feet MSL (64 to 68 feet bgs). Regionally, this upper most groundwater appears to be within relatively permeable sediments of the predominantly fine-grained Bellflower Aquitard. Most of the monitoring wells completed in the Bellflower Aquitard are at or near the water table, with screened depths ranging from approximately 58 to 91 feet bgs. Two deeper wells, WCC-1D and WCC-3D, were completed in a deeper zone with screened depths from approximately 120 to 140 feet bgs. Both of these wells have since been abandoned (Table I).

The following primary hydrogeologic units were recognized in the general vicinity of the Site:

FORMATION	HYDROSTRATIGRAPHIC UNIT	
Lakewood Formation (Upper Pleistocene)	Bellflower Aquitard	Upper Bellflower Aquitard (UBF)
		Middle Bellflower Aquitard (MBF, MBFM, MBFC, MBFB/C)
		Lower Bellflower Aquitard (LBF)
	Gage Aquifer (GAGE)	
San Pedro (Lower Pleistocene)	Gage Lynwood Aquifer (GLA)	
	Lynwood Aquifer (LYNWOOD)	
	Unnamed Aquifer	
	Silverado Aquifer	

The relatively fine-grained Upper Bellflower Aquitard (UBF) is continuous across the area, but thins to the northwest. The UBF is comprised of laminated to massive yellowish brown muds, with local sands and fossiliferous zones. The UBF is found at the surface beneath the Site, and is approximately 70 feet thick. A generalized geologic cross-section is included as Figure 3.

The Middle Bellflower Aquitard (MBF) is a massive, light yellowish brown, fine to medium sand, with local muddy zones. An extensive mud layer, referred to as the Middle Bellflower Mud (MBFM), locally interrupts this sand. Where divided, the sand subunits are referred to as the B-Sand (MBFB) and C-Sand (MBFC). The top of the MBFB is found at an approximate elevation of -12 to -20 feet MSL (64 to 72 feet bgs) at the Site, and is generally from 25 feet to 40 feet thick. The MBFM is discontinuous across the area, and is comprised of laminated silts, layered silts, and very fine sands. Deeper borings at the former ILM facility and the Site do not always encounter the MBFM. The top of the MBFC is found at an approximate elevation of -45 to -55 feet MSL (97 to 107 feet bgs) at the Site (Figure 3).

The fine-grained Lower Bellflower Aquitard (LBF) is reported continuous across the area. The top of the LBF occurs at an approximate elevation of -62 to -98 feet MSL

(114 to 150 feet bgs), and ranges in thickness from 10 to 25 feet thick (Figure 3). The LBF separates the Bellflower sands from the underlying Gage Aquifer. The Gage Aquifer in the Site vicinity is predominantly sand, and ranges in thickness from 40 to 78 feet. No monitoring wells have been drilled into the Gage Aquifer at the Site (Kennedy/Jenks Consultants, 2000).

3. GROUNDWATER SAMPLING PROCEDURES

3.1 Monitoring Plans

The 2003 Annual event at the Site was conducted from March 24th to the 28th, 2003, by Tait Environmental Management, Inc. (TEM) field personnel. Work was conducted in accordance with the following documents:

- *Groundwater Monitoring Workplan 2003*, by Haley & Aldrich, Inc., dated 9 December 2002, approved by the Los Angeles Regional Water Quality Control Board (LARWQCB) on 23 January 2003.

- *Standard Operating Procedure, Groundwater Gauging and Sampling*, prepared by Tait Environmental Management, dated 9 September 2002.

Monitored natural attenuation sampling was conducted according to:

- *Standard Operating Procedures for Measuring Natural Attenuation Parameters at Boeing Realty Corporation Former C-6 Facility, Revision 1.0*, prepared by Haley & Aldrich, Inc. and England Geosystem Inc., dated January 9, 2001.

Activities performed during the Annual Groundwater Monitoring and Sampling event were as follows.

Groundwater Elevation Measurement

- Water levels were measured in 20 Site groundwater wells on the 24th and 25th of March 2003 (Table II).

- A groundwater elevation contour map was generated based on these measurements (Figure 4).

Well Purging, Sampling and Analysis

- At least 3 wetted casing volumes of water were purged with a submersible pump from each well.

- Purge water was monitored for pH, temperature, and specific conductivity stability.

- Purging was completed when a minimum of three wetted casing volumes were removed and three consecutive measurements of pH, temperature, and specific conductance were within 10% of each other, or after five casing volumes were purged.

- Groundwater samples were collected from the 20 wells with a submersible pump and analyzed for VOCs by EPA Method 8260B.

- QA/QC samples were also collected and analyzed for VOCs by EPA Method 8260B.

Monitored Natural Attenuation (MNA) Parameters

- MNA parameters (DO, ORP, and pH) were measured in the field.

3.2 Field Procedures

Field procedures for this sampling event are outlined in the documents listed previously in Section 3.1.

3.3 Sample Naming

Groundwater samples were labeled in the following format, in accordance with the Boeing Data Management Plan (DMP) prepared by CH2Mhill, and dated January 2002 (CH2MHill, 2002):

For example: WCC_5S_WG032503_0001

Where:

WCC_5S = the groundwater monitoring well name
WG = Groundwater sample
032503 = date the sample was collected (mmddyy)
0001 = the number of samples taken from the well

3.4 Groundwater Monitoring Program Variances

Groundwater monitoring wells WCC-4S, WCC-12S and XMW-09 were scheduled for sampling during the Annual Monitoring Event; however, due to Site redevelopment construction activities, the groundwater monitoring wells could not be accessed by the sampling crew and equipment. Redevelopment construction activities should be nearly complete this fall, and WCC-4S and WCC-12S will be scheduled for sampling during the Semi-Annual Monitoring Event in October 2003. XMW-9 is a Montrose Chemical Company monitoring well, and will be sampled once construction activities in this area of the Site are complete and access to the well is feasible, also expected in the fall of 2003 for the October Semi-Annual Event.

4. MONITORING AND SAMPLING RESULTS

4.1 Groundwater Elevations

Field sheets for the data collected by TEM are included in Appendix A. A summary of the groundwater elevations for the 2003 Annual event is presented in Table II.

During the 2003 Annual event, groundwater elevations at the Site ranged from -12.83 to -14.56 feet MSL, or approximately 65 feet bgs. Overall, groundwater elevations have increased up to approximately 0.39 feet compared to the values measured in September 2002, with the exception of well TMW-5, which decreased approximately 0.16 feet. Historic groundwater levels are presented in Table III and depicted in Figures 5a through 5i.

Figure 4 is a groundwater elevation contour map of the MBFB (B-Sand) water-bearing zone, generated using data collected from the 2003 Annual event. The average horizontal hydraulic gradient in the MBFB was calculated to be approximately 0.0008 to 0.0009 ft/ft to the south in March 2003, as compared to approximately 0.0010 to 0.0014 ft/ft to the south calculated for September 2002. Based on the groundwater elevation contours shown on Figure 4, the hydraulic gradient varies across the Site along the various flow vectors. The groundwater in the MBFB appears to generally flow in a southerly direction and converge on the Site.

Historic groundwater levels are presented in Table III. Hydrographs for the wells are included as Figures 5a through 5i. The low gradient is demonstrated in the hydrographs by the extremely close proximity of the hydrographs from individual wells.

4.2 Groundwater Quality

VOC Results

Results of VOC analysis by EPA Method 8260B for the 2003 Annual event, conducted in March 2003, are summarized in Table IV, and in Figures 6 through 9. Based on visual observations during well sampling, TEM recorded no indications of dense non-aqueous phase liquid (DNAPL) in any of the sampled wells. Based on a review of previous monitoring reports, general plume geometries for trichloroethene (TCE) and 1,1-dichloroethene (1,1-DCE) appear to be generally unchanged since 1999 (Haley & Aldrich, Inc. and England Geosystem Inc., 2001b and 2001c and Haley & Aldrich, Inc., June 2002 and November 2002).

Figure 6 shows the dissolved-phase TCE concentrations in the MBFB. TCE concentrations in groundwater samples have either generally decreased (some significantly) or minimally increased (less than 20%) in 16 of the 20 wells, compared to the September 2002 sampling event; however, TCE concentrations notably increased in samples from 4 of the 20 wells:

- TMW-1, from 520 to 860 µg/l;
- TMW-2, from 8,400 to 14,000 µg/l;

- TMW-9, from 260 to 900 µg/l; and
- WCC-5S, from 1.5 to 3.6 µg/l.

Noteworthy decreases (greater than 20% variation from the previous sampling event) in TCE concentrations were observed in the samples collected from DAC-P1 (from 18,000 to 13,000 µg/l) and WCC-6S (from 2,000 to 400 µg/l). Concentration vs. time graphs for TCE in wells are included as Figures 7a through 7g.

Figure 8 shows the dissolved-phase 1,1-DCE concentrations in the MBFB. 1,1-DCE concentrations in groundwater samples have generally stayed the same or decreased in the monitored wells, with the following exceptions:

- TMW-4, from 660 to 1,200 µg/l;
- TMW-7, from 390 to 560 µg/l;
- TMW-8, from 3,100 to 3,900 µg/l; and
- TMW-9, from 35 to 240 µg/l.

It is important to note that 1,1-DCE has not been detected at DAC-P1, TMW-10, TMW-11 and TMW-14. Concentration vs. time graphs for 1,1-DCE in wells are included as Figures 9a through 9g.

Six wells were reported to have detectable concentrations of tetrachloroethene (PCE) up to 21 µg/l (BL-3). Five of the six samples with detected PCE concentrations are less than 6 µg/l; three of these concentrations were at low levels that could not be quantified by the laboratory, and are noted in Table IV with a "J" flag.

Concentrations of 1,1,1-trichloroethane (1,1,1-TCA) were not detected in 17 of the 20 wells sampled, and decreased in samples from the following three wells:

- TMW-2, from 1,400 to 1,300 µg/l;
- WCC-3S, from 670 to 96J µg/l; and
- WCC-6S, from 780 to 210 µg/l.

As in previous sampling events, some minor occurrences of VOCs other then those described above were detected, and are tabulated on Table IV. These VOCs occurrences included cis-1,2-DCE, chloroform, benzene, methyl ethyl ketone (MEK) and toluene, and are discussed below.

- Cis-1,2-DCE concentrations in groundwater generally remained the same (20% variances or less) in the 20 wells sampled, except in the following two wells: TMW-2 (from 14,000 to 4,700 µg/l) and WCC-3S (from 3,800 to 910 µg/l). These values are within the historical range of fluctuation for each well, as shown on Table V.

- Chloroform concentrations in groundwater samples generally remained the same (less than 20% variances) in the 20 wells sampled, except in the following two wells: TMW-2 and WCC-9S. Chloroform decreased in well TMW-2, from 240 to 110 µg/l, and in well WCC-9S, from 24 to 12 µg/l. These values are within historical range of fluctuation for each well, as shown on Table V.

- Benzene concentrations in groundwater samples generally remained the same or decreased, except in well WCC-3S. Well WCC-3S was reported to have a benzene concentration that could not be quantified by the laboratory (46J µg/l). Benzene was not detected in well WCC-3S in the previous sampling event (< 620 µg/l).

- MEK (2-butanone) was only detected in well TMW-14, at a concentration of 5.6 µg/l. In well TMW-2, MEK decreased from 140,000 µg/l to below laboratory detection limits (< 1,200 µg/l) in March 2003. Well TMW-2 demonstrated a similar concentration change during the 2002 annual sampling event.

- Toluene concentrations remained high in three wells (Table V). WCC-3S, decreased from 43,000 to 9,600 µg/l; WCC-6S, increased from 2,500 to 7,700 µg/l; TMW-2, decreased from 5,200 to 710 µg/l.

Field MNA Parameters

Field monitoring of DO, ORP, and pH was conducted during the March 2003 monitoring and sampling event. A summary of the March 2003 MNA parameters is included in Table VI, and on the Field Data Sheets in Appendix A. These parameters are generally similar to the March 2002 annual sampling event data, and suggest that in-situ conditions have not changed. The distribution of DO and ORP suggests evidence of intrinsic biotransformation of VOCs in the potential source area near former Buildings 1, 2 and 36, as well as along the southern property boundary. It appears that DO has been depleted within the areas of TCE and 1,1-DCE-impacted groundwater. ORP is negative within the Building 1/36 area (WCC-3S and WCC-6S), suggesting anaerobic reducing conditions.

5. QUALITY ASSURANCE/QUALITY CONTROL

5.1 Field Quality Control Samples

5.1.1 Field Duplicates

Two duplicate groundwater samples were analyzed for VOC concentrations from wells BL-3 and XMW-19. These results are included in Table IV. Duplicate laboratory data can be used to measure how well replicate measurements reproduce, and also to estimate overall method precision. Relative percent difference (RPD) is a measure of precision, and is calculated as follows:

(Result 1 – Result 2)/ ½ (Result 1 + Result 2) * 100%

The RPD will often vary with the concentration of analyte; RPD lessening as the concentration increases. If the variation is greater than plus or minus 15%, but less than 100%, the reported concentrations are up to standard. If the variation is greater than 100%, the data is subject to further evaluation (i.e., comparison with historic data from the well). The data from BL-3 and the BL-3 duplicat,e and from XMW-19 and the XMW-19 duplicate were reported to have RPDs less than or equal to 30%, which indicates that the reported concentrations are up to standard.

5.1.2 Equipment Rinsate Blanks

Two equipment rinsate blanks were collected during the sampling event after cleaning the sampling equipment with deionized water. These rinsate samples were analyzed for VOCs by EPA Method 8260B. VOCs were not detected in any of the equipment blank samples.

5.1.3 Field Blanks

Two field blanks were collected during the sampling event with laboratory-supplied water to check for contamination by sampling methodology. These field blank samples were analyzed for VOCs by EPA Method 8260B. An estimated concentration of acetone (3.3J µg/l) was detected below the contracting laboratory reporting limit (10 µg/l) in one of the field blanks, as shown on Table IV.

5.1.4 Trip Blanks

One laboratory-prepared trip blank was shipped to the laboratory each day to check for cross-contamination. The samples were analyzed for VOCs by EPA Method 8260B. Estimated concentrations of acetone (5.3J and 5.1J µg/l) were detected below the contracting laboratory reporting limit (10 µg/l) in two of the trip blanks. Concentrations of 2-butanone, methylene chloride and tetrahydrofuran were also

reported in one of the trip blanks at concentrations of 39, 0.34J and 36 µg/l, respectively, as shown in Table IV.

5.1.5 Data Validation and Laboratory QA/QC Samples

Final laboratory-certified reports and laboratory quality control procedures are included on the compact disc (CD) as Appendix B.

Tier II data validation was performed on 10% of the samples; Tier III data validation on 5% of the samples. Based on the data validation results, the data collected during this event is adequate for continued characterization and monitoring of VOCs in groundwater beneath the Site. Data validation results are provided in Appendix C. Appropriate data qualifiers, as determined by Laboratory Data Consultants, Inc. (LDC) (data validation subcontractor), have been included where appropriate.

6. LIMITATIONS

The limitations of this report are included as Appendix D.

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